What is claimed is:

1. An optical pickup apparatus for conducting recording and/or reproducing information of an optical information recording medium, comprising:

a light source;

a converging optical system to converge light flux emitted from the light source on an information recording plane of the optical information recording medium so as to conduct reproducing and/or recording information of the optical information recording medium, the converging optical system having an objective lens; and

a photo-detector to receive reflected light flux from the information recording plane;

wherein the converging optical system comprises at least a plastic lens and a spherical aberration deviation correcting element to correct deviation of a spherical aberration of the converging optical system and a numerical aperture of the objective lens at an image-side is 0.65 or more.

2. The optical pickup apparatus of claim 1, wherein the spherical aberration deviation correcting element comprises a movable element movable in a direction of an optical axis.

3. The optical pickup apparatus of claim 2, wherein the converging optical system comprises a coupling lens including at least a lens group working as the movable element of the spherical aberration deviation correcting element.

4. The optical pickup apparatus of claim 3, wherein the light flux emitted from the light source has a wavelength of 500 nm or less, the coupling lens has at least a diffractive surface having a ring-shaped diffractive structure, the lens having the diffractive surface is a plastic lens, the movable lens is a plastic lens and the objective lens is a plastic lens.

5. The optical pickup apparatus of claim 3, wherein the converging optical system comprises the coupling lens groups having at least two lens groups and at least one of the two lens groups works as the movable element of the spherical aberration deviation correcting element.

6. The optical pickup apparatus of claim 3, wherein the converging optical system comprises the coupling lens consisting of one lens group and the lens group works as the

movable element of the spherical aberration deviation correcting element.

7. The optical pickup apparatus of claim 6, wherein the following formula is satisfied:

$$0.05 \leq |m| \leq 0.5 \quad (m < 0)$$

where m represents a magnification of a combined optical system of the objective lens and the coupling lens.

8. The optical pickup apparatus of claim 2, wherein the converging optical system comprises a coupling lens and the converging optical system further comprises a positive lens group having at least a positive lens and a negative lens group having at least a negative lens between the coupling lens and the objective lens, and

wherein at least one of the positive lens group and the negative lens group works as the movable element of the spherical aberration deviation correcting element.

9. The optical pickup apparatus of claim 8, wherein the converging optical system comprises a beam expander having the positive lens group and the negative lens group and at least one of the positive lens group and the negative lens

group is the movable element of the spherical aberration deviation correcting element.

10. The optical pickup apparatus of claim 9, wherein the light flux emitted from the light source has a wavelength of 500 nm or less, at least one of the positive lens group and the negative lens group comprises at least a diffractive surface having a ring-shaped diffractive structure, the lens having the diffractive surface is a plastic lens, the movable element is a plastic lens and the objective lens is the plastic lens.

11. The optical pickup apparatus of claim 8, wherein the following formula is satisfied:

$$|fP/fN| \geqq 1.1$$

where fP is a focal length (mm) of the positive lens group (where, when the diffractive surface is provided to the positive lens group, fP is the total focal length in which the refractive power and diffractive power are combined); and fN is a focal length (mm) of the negative lens group (where, when the diffractive surface is provided to the negative lens group, fN is the total focal length in which the refractive power and diffractive power are combined).

12. The optical pickup apparatus of claim 2, wherein the movable element is a plastic lens.

13. The optical pickup apparatus of claim 2, wherein the movable element is an aspherical lens having at least an aspherical surface.

14. The optical pickup apparatus of claim 1, wherein the spherical aberration deviation correcting element is a stationary element which does not move in a direction of an optical axis.

15. The optical pickup apparatus of claim 14, wherein a refractive index distribution of the stationary element along the direction perpendicular to the optical axis is changeable.

16. The optical pickup apparatus of claim 1, wherein the converging optical system comprises an axial chromatic aberration correcting element to correct an axial chromatic aberration of the converging optical system.

17. The optical pickup apparatus of claim 16, wherein the axial chromatic aberration correcting element comprises a

positive lens group having at least a positive lens and a negative lens group having at least a negative lens, and the following formula is satisfied:

$$\nu dP > \nu dN$$

where νdP is an average of Abbe's numbers of d-lines of all positive lenses in the converging optical system, and
νdN is an average of Abbe's numbers of d-lines of the all negative lenses in the converging optical system.

18. The optical pickup apparatus of claim 17, wherein the following formula is satisfied:

$$\nu dP > 55$$

$$35 > \nu dN$$

19. The optical pickup apparatus of claim 16, wherein the axial chromatic aberration correcting element comprises a diffractive surface having a ring-shaped diffractive structure.

20. The optical pickup apparatus of claim 19, wherein the following formula is satisfied:

$$|a| > |b|$$

where "a" is an axial chromatic aberration caused by refractive index dispersion of the converging optical system as the wavelength of the light source fluctuates, and "b" is the total of the axial chromatic aberration caused by the refractive index dispersion of the converging optical system and by the diffractive surface as the wavelength of the light source fluctuates.

21. The optical pickup apparatus of claim 19, wherein the under-corrected spherical aberration caused by the diffractive surface as the wavelength of the light source increases corrects the over-corrected spherical aberration caused by the refractive index dispersion of the converging optical system as the wavelength of the light source increase.

22. The optical pickup apparatus of claim 19, wherein the diffractive surface makes a diffracted light amount of n-th ordered diffracted ray (n is an integer except 0, $\pm$ 1) larger than a diffracted light amount of any other ordered diffracted ray.

23. The optical pickup apparatus of claim 16, wherein the axial aberration correcting element satisfies the following formula:

$$P2 < P1 < P3$$

where P1 is a paraxial power of the axial chromatic aberration correcting element at the wavelength of the light source, P2 is a paraxial power of the axial chromatic aberration correcting element at the wavelength shorter by 10 nm than the wavelength of the light source, and P3 is a paraxial power of the axial chromatic aberration correcting element at the wavelength longer by 10 nm than the wavelength of the light source,

(Where, when the axial chromatic aberration correcting element comprises a diffractive surface, each of the paraxial powers P1, P2 and P3 is a total paraxial power in which a paraxial refractive power and a paraxial diffractive power are combined).

24. The optical pickup apparatus of claim 1, wherein the objective lens comprises a single lens having an aspherical surface on at least one surface thereof.

25. The optical pickup apparatus of claim 24, wherein the objective lens satisfies the following conditional formula:

$$1.1 \leqq d1/f \leqq 3.0$$

where d1 is axial lens thickness, and

f is a focal length of the objective lens (where, when the objective lens comprises a diffractive surface having a ring-shaped diffractive structure, f is the total focal length in which a paraxial refractive power and a paraxial diffractive power are combined).

26. The optical pickup apparatus of claim 24, wherein the objective lens is a plastic lens.

27. The optical pickup apparatus of claim 1, wherein the optical pickup apparatus conducts reproducing and/or recording information of at least two kinds of optical information recording media, the light source is a first light source to emit a first light flux having a wavelength $\lambda 1$ in order to conduct reproducing and/or recording information of a first information recording medium having a first transparent substrate, the optical pickup apparatus further comprises a second light source to emit a second light flux having a wavelength $\lambda 2$ different from the wavelength $\lambda 1$ in order to conduct reproducing and/or recording information of a second information recording

medium having a second transparent substrate having a thickness different from that of the first transparent substrate; and the converging optical system converges at least a part of the first light flux on an information recording plane of the first optical information recording medium so as to conduct recording and/or reproducing information of the first optical information recording medium and converges at least a part of the second light flux onto an information recording plane of the second optical information recording medium so as to conduct recording and/or reproducing information of the second optical information recording medium.

28. The optical pickup apparatus of claim 27, wherein the spherical aberration deviation correcting element corrects deviation of the spherical aberration due to a thickness difference between the first transparent substrate and the second transparent substrate.

29. The optical pickup apparatus of claim 27, wherein the objective consists of a single lens having at least one aspherical surface and satisfies the following formula:

$$0.7 \leqq d1/f \leqq 2.4$$

where d1 is an axial lens thickness of the objective lens and f is a focal length of the objective lens at a wavelength $\lambda 1$ (where, when the objective lens comprises a diffractive surface having a ring-shaped diffractive structure, f is the total focal length in which a paraxial refractive power and a paraxial diffractive power are combined).

30. The optical pickup apparatus of claim 27, wherein the objective lens has at least a diffractive surface having a ring-shaped diffractive structure and the objective lens converges at least a part of the first light flux on an information recording plane of the first optical information recording medium within a predetermined numerical aperture of the objective lens at an image side necessary for conducting recording and/or reproducing information of the first optical information recording medium on a condition that a wavefront aberration is $0.07\lambda 1$ rms or less and converges at least a part of the second light flux on an information recording plane of the second optical information recording medium within a predetermined numerical aperture of the objective lens at an image side necessary for conducting recording and/or reproducing information of the second optical

information recording medium on a condition that a wavefront aberration is 0.07λ2 rms or less.

31. The optical pickup apparatus of claim 27, wherein the objective lens comprises a ring-shaped stepped section to divide an incident light flux into k pieces of ring-shaped light flux by a refracting action where k ≥ 3 and the light flux is named the first, the second, - - the k-th light flux from the optical axis to the outside, a spherical aberration component of the wavefront aberration of the first and the k-th light flux at a best image plane position formed by the first and the k-th light flux is 0.07λ1 rms or less, at least two pieces of light flux among the second to (k-1)th light flux form an apparent best image plane position at a different position from the best image plane position formed by the first and k-th light flux, and the wavefront aberration of rays of each of in the first to k-th light flux passing within a predetermined numerical aperture of the objective lens at an image side necessary for conducting recording and/or reproducing information of the first optical information recording medium at the best image plane position formed by the first and k-th light flux is almost mi λ1, where mi is an integer, and i =1, 2, ---k.

32. The optical pickup apparatus of claim 29, wherein the objective lens is a plastic lens.

33. The optical pickup apparatus of claim 1, wherein the optical information recording medium comprises a plurality of information recording planes on one side of the optical information recording medium and converging optical system converges the light flux emitted from the light source onto each of the plurality of information recording planes of the optical information recording medium so as to conduct reproducing and/or recording information of the optical information recording medium.

34. The optical pickup apparatus of claim 33, wherein the spherical aberration deviation correcting element corrects deviation of the spherical aberration due to a difference in the thickness between a light flux incident surface of the optical information recording medium and each of the plurality of information recording planes of the optical information recording medium.

35. The optical pickup apparatus of claim 1, wherein the deviation of the spherical aberration of the converging

optical system is deviation of the spherical aberration due to change in temperature and/or humidity.

36. The optical pickup apparatus of claim 1, wherein the deviation of the spherical aberration of the converging optical system is deviation of the spherical aberration due to deviation in the wavelength of the light source and/or the manufacturing errors in the wavelength of the light source.

37. The optical pickup apparatus of claim 1, wherein the deviation of the spherical aberration of the converging optical system is deviation of the spherical aberration due to deviation in thickness of a transparent substrate of the optical information recording medium.

38. The optical pickup apparatus of claim 1, wherein the wavelength of the light source is 500 nm or less.

39. The optical pickup apparatus of claim 1, wherein the spherical aberration deviation correcting element is capable of correcting the spherical aberration of $A\lambda$ rms to 0.07 λ rms or less, where A satisfies the following formula: $0.07 < A \leq 0.5$.

40. An optical information recording medium recording and/or reproducing apparatus for conducting recording and/or reproducing information of an optical information recording medium, comprising:

an optical pickup apparatus comprising:

a light source;

an converging optical system to converge light flux emitted from the light source on an information recording plane of the optical information recording medium so as to conduct reproducing and/or recording information of the optical information recording medium, the converging optical system having an objective lens; and

a photo-detector to receive reflected light flux from the information recording plane;

wherein the converging optical system comprises at least a plastic lens and a spherical aberration deviation correcting element to correct deviation of a spherical aberration of the converging optical system and a numerical aperture of the objective lens at an image-side is 0.65 or more.

41. A spherical aberration deviation correcting element for use in an optical pickup apparatus for recording and/or

reproducing information of the optical information recording medium, comprising:

a positive lens group having at least a positive lens; and

a negative lens group having at least a negative lens, wherein at least one of the positive lens group and the negative lens group is a movable element movable in a direction of an optical axis and the movable element can change the slope angle of the marginal ray of an exit light flux by moving in a direction of the optical axis, and wherein each positive lens of the spherical aberration deviation correcting element has Abbe's numbers of 70 or less or each negative lens of the spherical aberration deviation correcting element has Abbe's numbers of 40 or more and the spherical aberration deviation correcting element comprise at least a diffractive surface having a ring-shaped diffractive structure.

42. The spherical aberration deviation correcting element of claim 41, wherein the following formula is satisfied:

$P2 < P1 < P3$

where P1 is a paraxial power of the spherical aberration deviation correcting element at the wavelength of the light source of the optical pickup apparatus,

P2 is a paraxial power of the spherical aberration deviation correcting element at the wavelength shorter by 10 nm than the wavelength of the light source of the optical pickup apparatus, and

P3 is a paraxial power of the spherical aberration deviation correcting element at the wavelength longer by 10 nm than the wavelength of the light source of the optical pickup apparatus,

wherein each of the paraxial powers P1, P2 and P3 is a total paraxial power in which a paraxial refractive power and a paraxial diffractive power are combined.

43. The spherical aberration deviation correcting element of claim 41, wherein the spherical aberration deviation correcting element is a beam expander.

44. The spherical aberration deviation correcting element of claim 41, wherein the spherical aberration deviation correcting element comprises at least an optical element made of plastic.

45. A spherical aberration deviation correcting unit for use in an optical pickup apparatus for recording and/or

reproducing information of an optical information recording medium, comprising:

a spherical aberration deviation correcting element recited in claim 41, and

a moving device to move at least one of the positive lens group and the negative lens group in a direction of an optical axis.

46. The spherical aberration deviation correcting element unit of claim 45, wherein the following formula is satisfied:

$$P2 < P1 < P3$$

where P1 is a paraxial power of the spherical aberration deviation correcting element at the wavelength of the light source of the optical pickup apparatus,

P2 is a paraxial power of the spherical aberration deviation correcting element at the wavelength shorter by 10 nm than the wavelength of the light source of the optical pickup apparatus, and

P3 is a paraxial power of the spherical aberration deviation correcting element at the wavelength longer by 10 nm than the wavelength of the light source of the optical pickup apparatus,

where each of the paraxial powers P1, P2 and P3 is a total paraxial power in which a paraxial refractive power and a paraxial diffractive power are combined.

47. The spherical aberration deviation correcting element unit of claim 45, wherein the spherical aberration deviation correcting element is a beam expander.

48. The spherical aberration deviation correcting element unit of claim 45, wherein the spherical aberration deviation correcting element comprises at least an optical element made of a plastic.